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Fermi large area telescope highlights

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ABSTRACT

Successfully launched in June 2008, the Fermi Gamma-ray Space Telescope, formerly named GLAST, has been observing the high-energy gamma-ray sky with unprecedented sensitivity in the 20 MeV–300 GeV energy range and electrons + positrons in the 7 GeV–1 TeV range, opening a new observational window on a wide variety of astrophysical objects.

1. Introduction

The Fermi Observatory carries two instruments on-board: the Gamma-ray Burst Monitor (GBM) [1] and the Large Area Telescope (LAT) [2]. The GBM, sensitive in the energy range between 8 keV and 40 MeV, is designed to observe the full unocculted sky with rough directional capabilities (at the level of one to a few degrees) for the study of transient sources, particularly Gamma-Ray Bursts (GRBs). The LAT is a pair conversion telescope for photons above 20 MeV up to a few hundreds of GeV. The operation of the instrument through the first 3 years of the mission was smooth at a level which is probably beyond the more optimistic pre-launch expectations. The LAT has been collecting science data for more than 99% of the time spent outside the South Atlantic Anomaly (SAA). The remaining tiny fractional down-time accounts for both hardware issues and detector calibrations. More than 650 million gamma-ray candidates (i.e. events passing the background rejection selection) were made public and distributed to the Community through the Fermi Science Support Center (FSSC).[1] Over the first 3 years of mission the LAT collaboration has put a considerable effort toward a better understanding of the instrument and of the environment in which it operates. In addition to that a continuous effort was made in order to make the advances public as soon as possible. In August 2011 the first new event classification (Pass 7) since launch was released, along with the corresponding Instrument Response Functions. Compared with the pre-launch (Pass 6) classification, it features a greater and more uniform exposure, with a significance enhancement in acceptance below 100 MeV.

2. The Second Fermi–LAT catalog

The high-energy gamma-ray sky is dominated by diffuse emission: more than 70% of the photons detected by the LAT are produced in the interstellar space of our Galaxy by interactions of high-energy cosmic rays with matter and low-energy radiation fields. An additional diffuse component with an almost-isotropic distribution (and therefore thought to be extragalactic in origin) accounts for another significant fraction of the LAT photon sample. The rest consists of various different types of point-like or extended sources: Active Galactic Nuclei (AGN) and normal galaxies, pulsars and their relativistic wind nebulae, globular clusters, binary systems, shock-waves remaining from supernova explosions and nearby solar-system bodies like the Sun and the Moon.

The Second Fermi–LAT catalog (2FGL) [3] is the deepest catalog ever produced in the energy band between 100 MeV and 100 GeV. Compared to the First Fermi–LAT (1FGL) [4], it features several significant improvements: it is based on data from 24 (vs. 11) months of observation and makes use of the new Pass 7 event selection. The energy flux map is shown in Fig. 1 and the sky-distribution of the 1873 sources is shown in Fig. 2. It is interesting to note that 127 sources are firmly identified, based either on periodic variability (e.g. pulsars) or on spatial morphology or on correlated variability. In addition to that 1170 are reliably associated with sources known at other wavelengths, while 576 (i.e. 31% of the total number of entries in the catalog) are still unassociated.

3. Indirect Dark Matter searches

One of the major open issues in our understanding of the Universe is the existence of an extremely–weakly interacting form of matter, the Dark Matter (DM), supported by a wide range of observations including large scale structures, the cosmic microwave background and the isotopic abundances resulting

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[1] The FSSC is available at http://fermi.gsfc.nasa.gov/ssc

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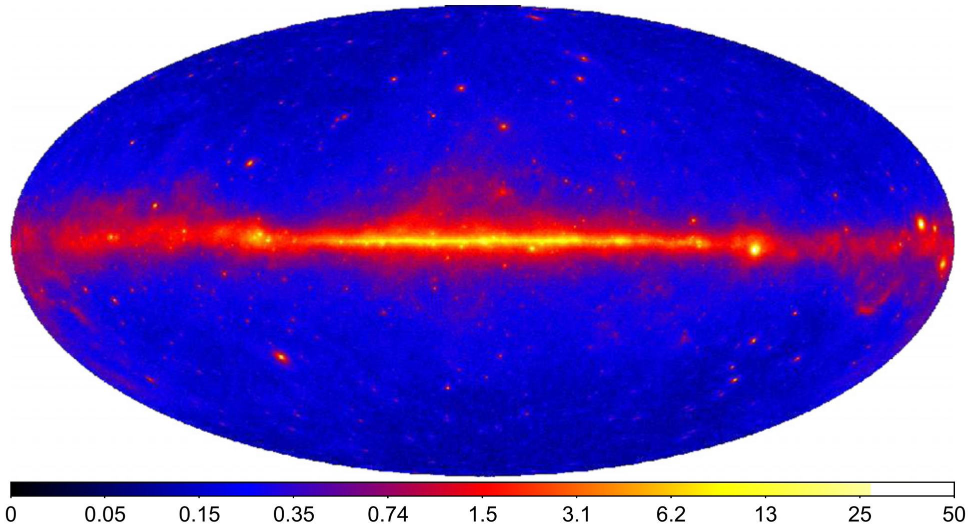

Fig. 1. Sky map of the energy flux derived from 24 months of observation. The image shows gamma-ray energy flux for energies between 100 MeV and 10 GeV, in units of 10^{-7} erg cm^{-2} s^{-1} sr^{-1}.

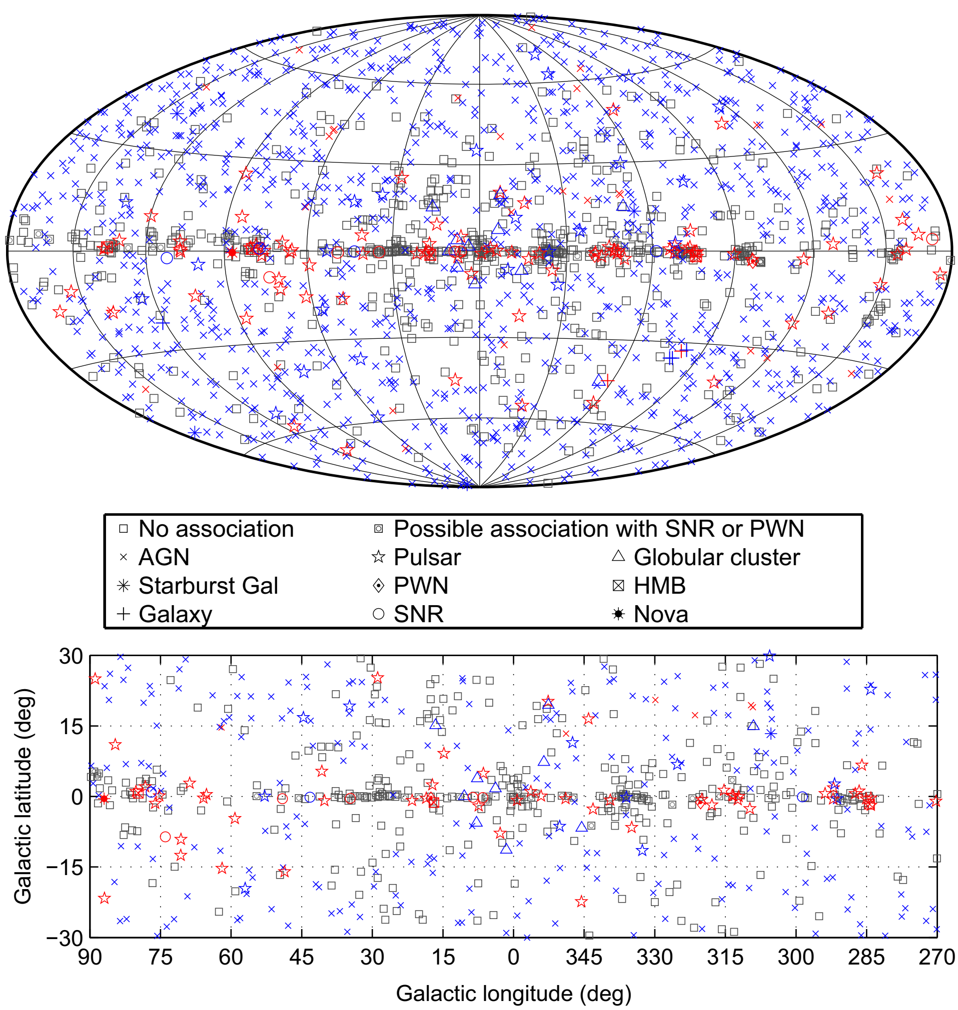

Fig. 2. Full sky map (top) and blow-up of the inner Galactic region (bottom) showing sources by source class. Identified sources are shown with a red symbol, associated sources in blue. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

from the primordial nucleosynthesis. Complementary to direct searches being carried out in underground facilities and at accelerators, the indirect search for DM is one of the main items in the broad Fermi Science menu. The word indirect denotes here the search for signatures of Weakly Interactive Massive Particle (WIMP) annihilation or decay processes through the final